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ABSTRACT

A study designed to examine biological, sociological, and early maturational correlates of intelligence collected data prospectively, from birth to 15 years of age, on a sample of 987 black children. Multiple indicators of eight independent and three dependent variables were tested in a structural equation model. Altogether, clear sex differences appeared in the relationship between verbal/spatial IQ at 7 years of age and achievement at age 15. For males, only verbal IQ was positively linked with achievement; for females, both verbal and spatial IQ were positively linked, with spatial IQ showing the stronger effect. With regard to early influences on verbal IQ, both biological and environmental factors were significant for females; only environmental factors were significant for males. However, biological factors were more significant for males in relationship to spatial IQ. Concerning total effects on achievement, socioeconomic factors were stronger than other variables for both sexes, although biological influences were more significant for females. These findings supported literature indicating the relatively more symmetrical development of the left and right cerebral hemispheres among females. Data also supported evidence of earlier development of right hemispheric capacities among black females, although the reverse relationship has previously been found with white samples. (Directions for future research are suggested.) (Author/RH)

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NEUROPSYCHOLOGICAL AND EARLY MATURATIONAL CORRELATES
OF INTELLIGENCE

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ABSTRACT

NEUROPSYCHOLOGICAL AND EARLY MATURATIONAL CORRELATES OF INTELLIGENCE

This study examined biological, sociological, and early maturational correlates of intelligence collected prospectively from birth to age 15 on 987 black children. Multiple indicators of eight independent variables and three dependent variables were tested in a structural equation model. Altogether, clear sex differences appeared in the relationships between Verbal and Spatial IQ at age 7 and achievement at age 15. For males, only Verbal IQ was positively linked with achievement; for females, both Verbal and Spatial IQ were positively linked, with Spatial IQ showing the stronger effect. In terms of early influences on Verbal IQ, both biological (e.g., physical development) and environmental (e.g., socioeconomic status) factors were significant for females, whereas only environmental factors were significant for males. However, biological factors were more significant with Spatial IQ for males. Concerning total effects on achievement, socioeconomic factors were stronger than other variables for both sexes, although biological influences were more significant for females. These findings support literature indicating the relatively more symmetrical development of the left and right cerebral hemispheres (as measured respectively by Verbal and Spatial IQ among females). They also support evidence of earlier development of right hemispheric capacities among black females, although the reverse relationship has been found with white samples. The importance of biological factors relative to Verbal IQ and later achievement for females, but Spatial IQ for males, is striking—and should be explored in future research.

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INTRODUCTION

Substantial evidence points to sex differences in specific types of cognitive abilities (Anastasi, 1958; Benbow and Stanley, 1980; Maccoby and Jacklin, 1974; McGlone, 1980). Females score somewhat higher than males on certain verbal tasks, such as articulation and grammar; in contrast, males score considerably higher on spatial tasks, such as disembedding figures and mental rotation (Maccoby and Jacklin, 1974; McGlone, 1980). A spatial advantage for males increases after puberty and persists through adulthood (Harris, 1978; McGuinness and Pribram, 1979), despite no consistent sign of sex differences in general intelligence (Wechsler, 1944, 1949).

The evidence for sex differences in cognitive functioning is not disputed; however, its determinants are. The controversy focuses on the extent to which intellectual variation is explained in terms of biological or environmental factors. Research on the etiology of cognitive differences reveals a complex interaction of social, genetic, hormonal, and neuroanatomical influences (Burstein et al., 1980; Waber, 1976, 1977).

Cerebral Lateralization

Evidence of anatomical and functional sex differences in cerebral lateralization in particular (McGlone, 1980) provides one compelling explanation for cognitive variation. In most individuals, the left cerebral hemisphere specializes in processing verbal stimuli, whereas the right hemisphere specializes in processing spatial stimuli (Bogen, 1969). Recently, consistent sex differences in hemispheric specialization have been found (Bryden, 1979; Harshman, 1976; Kimura, 1969; Levy and Gur, 1980; Levy and Reid, 1976; McGuinness and Pribram, 1979). Generally, males are more asymmetric in cognitive abilities, and demonstrate hemispheric

specialization in spatial skills relative to females, who are more bilateral in verbal abilities, and show competing verbal and spatial lateralized functions (Harris, 1978). Thus, males perform better than females on spatial tasks, such as the performance subtests of the Wechsler Intelligence Scale for Adults (WAIS); in contrast, females perform better than males on verbal tasks, such as the verbal subtests of the WAIS (Maccoby and Jacklin, 1974).

Developmental Influences

The processes underlying the development of sex differences in cognition emerge from results of hemispheric research on children. In her study of verbal and spatial performance among children aged 5 to 8 years, Levy (1976) provides data which indicate that the left hemisphere matures earlier than the right in girls, while the right hemisphere matures earlier than the left in boys. Both Levy (1976) and Harris (1978) suggest that, relative to girls, boys' lag in verbal development facilitates the acquisition of spatial skills, particularly in combination with differential sex role socialization of skills.

The importance of social factors is demonstrated by a number of recent studies (TenHouten, 1980; Thompson, 1979) showing sociocultural and racial influences on lateralization. According to TenHouten (1980), for example, blacks are more right hemisphere-dominant than whites. Moreover, females are more right hemisphere-dominant than males among blacks and lower-to-middle socioeconomic status whites, whereas the reverse trend is evident among higher socioeconomic status whites.

Schratz (1978) provides a sociocultural interpretation of her finding that black females score higher on spatial tasks than black males, whereas white females score lower on spatial tasks than white males. However, Jahoda (1980) reports

similar magnitudes of better spatial performance for males among black and white children in two cultures which differ considerably in early sex role socialization and opportunities for spatially oriented activities.

Biology-Environment Interaction

Recent investigations of the biology-environment interaction in cognitive functioning suggest that social and environmental factors augment, or perhaps create, initial biological sex differences which are then environmentally perpetuated (Ray and Newcombe, 1980). The recurrent finding that sex differences in functional brain asymmetry are weak prior to puberty suggests that maturational factors, possibly in interaction with environmental ones, may influence the degree of brain asymmetry (McGlone, 1980). The effect of pubertal and postpubertal sex hormone level on lateralization and cognitive skills has been extensively investigated, although with no definite conclusions (Hoyenga and Hoyenga, 1979). However, Waber (1976, 1977) and others (e.g., Nottebohm, 1979) argue that sex differences in cognitive abilities reflect differences in hemispheric organization, which in turn are related to differential rates of physical maturation. Late-maturing adolescents perform better on tests of spatial than verbal abilities, and are more lateralized for speech, than early-maturing adolescents who show the opposite pattern. Thus, females, who generally mature earlier than males, are relatively less lateralized (Waber, 1976, 1977).

Evidence also exists that males and females mature physically at different rates among different ethnic groups. For example, Malina (1970) supports Todd's (1931) earlier finding of negligible differences in skeletal maturation, an excellent indicator of physical growth, among black and white preschool and adoles-

cent males but advanced skeletal maturation of black females, particularly in ages approaching adolescence. It has been suggested (Denno et al., 1982) that the advanced maturation of black females may be linked to their relatively more predominant right-hemispheric capabilities.

Confounding Effects

Evidence that hemispheric capacity or lateralization may be genetically established at birth (Bryden, 1979:207; Nottebohm, 1979) or result from early physical asymmetry—e.g., size at birth, perinatal maturation rate (Bever, 1980)—could confound proposed associations between adolescent development and hemisphericity. Waber (1980:24) admits that

...there are data suggesting that stable individual differences in body composition emerge early in life... Therefore, it may be that patterns of neuropsychological functioning related to hormonal status are laid down in the central nervous system early in life, but it is only at puberty that they can be clearly observed.

Alternatively, early central nervous system (CNS) insult, resulting from prenatal or perinatal trauma, could contribute to differences in brain asymmetry, possibly in interaction with physical or developmental factors. Associations between fetal-neonatal brain trauma and consequent cerebral dysfunction have been researched extensively (see, for example, Towbin, 1970, 1971, 1978), although only recently with more "benign" correlates such as indicators of laterality (especially handedness) and hemispheric specialization (for a review of the literature, see Coren and Porac, 1980). According to Bakan, Dibb, and Reed (1973), the greater vulnerability of the left hemisphere to the hypoxic effects of some birth stress may influence early hemispheric organization, resulting in a "switch" from right- to left-handedness. Some support exists for this argument (Coren and Porac, 1980), in addition to evidence that maternal factors may also influence

birth events directly (Mednick, 1970) and, more indirectly, hemisphericity (Coren and Porac, 1980). Conceivably, birth events could also have a differential effect on males, given evidence that anatomical asymmetry is "not as marked for males relative to females within the first few days of life" (Witelson and Pallie, 1973:644).

The Present Study

Altogether, numerous biological and environmental factors have been suggested as possible correlates of cerebral development and intellectual performance. As yet, however, no study has examined a number of these key correlates simultaneously, or at different ages among the same individuals. Research on different ethnic groups is also limited.

The present study was designed to investigate the nature and extent of selected biological and environmental correlates of verbal and spatial intelligence within a sample of black children similar to the sample studied by Malina (1970; see also Eveleth et al., 1979). Two major hypotheses were examined: (1) Females would show evidence of greater lateralization of the left and right cerebral hemispheres, as well as greater right hemispheric capacities. (2) These sex differences would be linked to early CNS events, such as birth stress, as well as maturational factors, such as physical growth.

METHOD

Subjects

Subjects were selected from a sample of 2958 black children whose mothers participated in the Philadelphia Collaborative Perinatal Project (CPP) at Penn-

sylvania Hospital between 1959 and 1962. Pennsylvania Hospital was one of twelve medical centers included by the National Institute of Neurological Diseases and Stroke (NINDS) in a nationwide study of genetic, biological, and environmental influences upon child development. (For a description of the study, see Niswander and Gordon, 1972). Thus, the total sample reflects, in part, the characteristics of children born to a self-selected group of women who were interested in receiving inexpensive maternity care.

The sample of 987 subjects used for analyses fit the following criteria: i. located in a Philadelphia public school; ii. stayed in Philadelphia from ages 10 through 17; iii. received selected intelligence or achievement test scores; and iv. were not among sibling members excluded from the sample to prevent possible biases of multiple family membership. Comparisons between the final sample of 987 subjects and the excluded sample of 1971 subjects showed no significant differences on six key variables: i. the distribution of males and females; ii. total family income at registration; iii. total family income at 7 years; iv. per capita income at 7 years; v. number of prenatal examinations the mother attended; and vi. mother's age. In general, the final sample appeared to be representative of the sample from which it was drawn. (A more detailed description of this selection process may be found in Denno, 1982).

Technique

Longitudinal relationships among selected variables were examined using structural equation models which combine features of both factor analysis and regression analysis. The models are referred to by a number of different terms, such as simultaneous equation systems, linear causal schemes, etc. The models are especially appropriate for analyzing longitudinal panel data because each

equation represents a "causal link", in contrast to other techniques such as ordinary least squares (OLS) regression where each equation represents an empirical association (Goldberger, 1973:2). OLS regression is also based upon the assumption that measurement error in explanatory variables does not exist. However, in the social sciences, valid and reliable single indicators for theoretical concepts such as intelligence and cerebral dominance are frequently unavailable. Consequently, the errors in the equations representing the omitted variables may be biased.

Jöreskog (1973) has developed a general linear model for the analysis of covariance structures which allows for both error in the equations and error in the variables. The general model is a system of equations relating both unobservable and observable independent and dependent variables with an underlying causal structure. The model assumes multivariate normality and linearity, and comprises two parts:

- (1) the measurement model, which "specifies how the latent variables or hypothetical constructs are measured in terms of the observed variables..."; and
- (2) the structural equation model, which "specifies the causal relationships among the latent variables and are [sic] used to describe the causal effects and the amount of unexplained variance" (Jöreskog and Sörbom, 1978:4).

The measurement model can be regarded as a restricted confirmatory factor analysis as opposed to an unrestricted exploratory factor analysis. Thus, hypothesis testing for the model is identical to testing a confirmatory factor model.

Initial Structural Equation Model

The initial structural equation model which was used as a theoretical frame-

work for relationships among males and females is presented in Figure 1. Direct and indirect associations are illustrated across three different points in time for eight independent factors and three dependent factors. The relationships among factors are represented in three ways: (1) the expected correlations among the eight independent factors are represented by ϕ ; (2) the effects of independent factors upon dependent factors are represented by γ ; and (3) the effects of one dependent factor upon another dependent factor is represented by β . As is shown, ξ indicates a latent independent factor and η indicates a latent dependent factor.

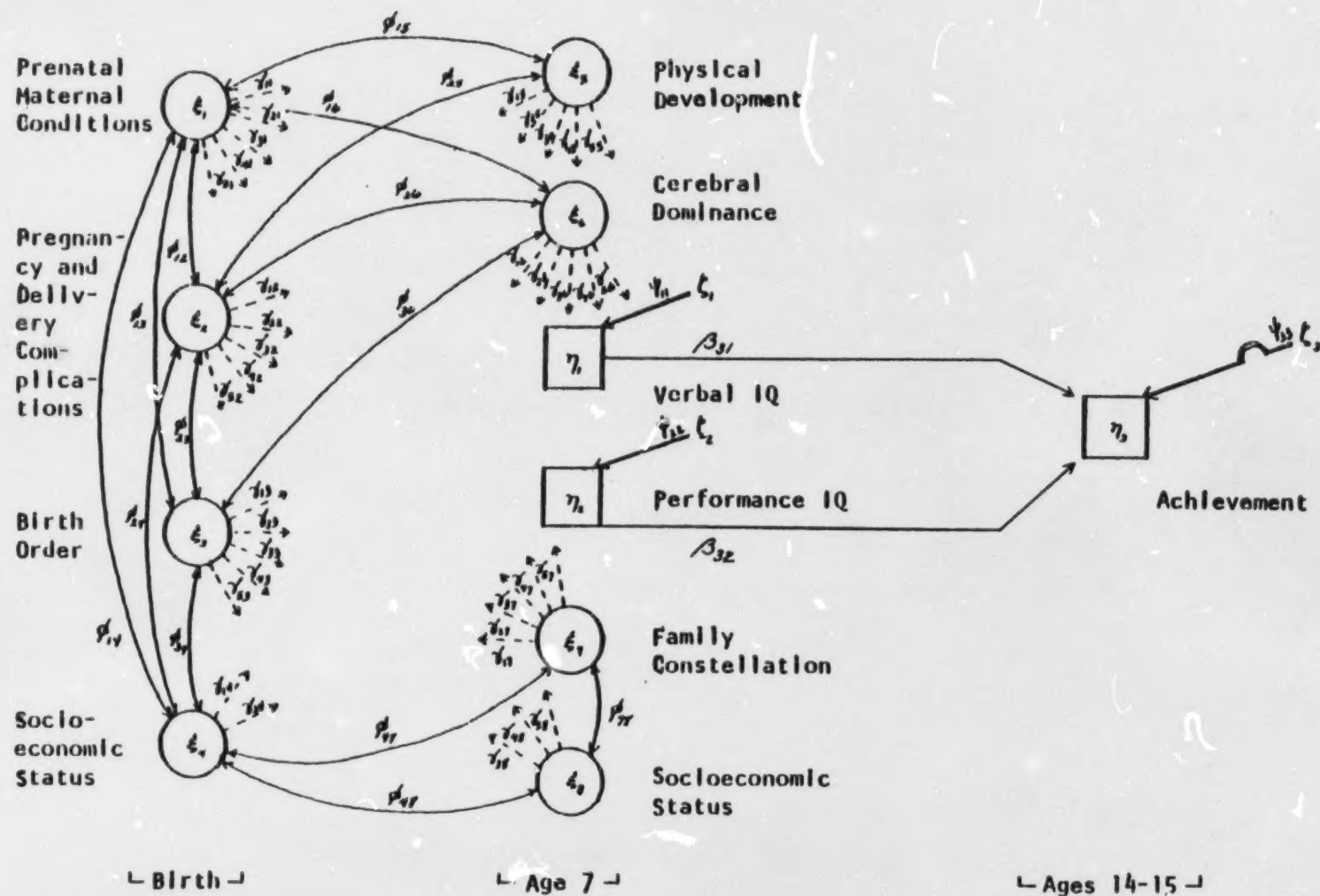
Initial Measurement Model

The initial measurement model consisted of eight latent independent factors, with 28 indicators, and three latent dependent factors, with 19 indicators. Indicators for the latent independent and dependent factors are specified as "x" or "y", respectively, in Table 1. The first subscript refers to the latent factor; the second subscript refers to the indicator. A description of the validity, reliability, and composition of individual indicators, and how they contribute to latent factors, may be found in Denno, 1982.

Testing of Measurement and Structural Equation Models

Testing of the measurement and structural equation models involved examining each of the 11 factors separately by confirmatory factor analysis. The procedure involved in determining the appropriate "fit" of each model is described in Denno, 1982 and Jöreskog and Sörbom, 1974.

In general, factors for the final structural equation model, particularly



15 FIGURE 1. THEORETICAL MODEL: SELECTED INDEPENDENT AND DEPENDENT VARIABLES

TABLE 1
INDEPENDENT AND DEPENDENT FACTORS

Latent Independent Factors

ξ_1 Prenatal Maternal Conditions

- X_{11} Number of Prenatal Examinations
- X_{12} Number of Prenatal Conditions - A sumscore of 8 items: heavy smoker, use of sedatives, single marital status, diabetic, hypertensive, venereal disease, neurological or psychiatric conditions, infectious conditions.
- X_{13} Poor Obstetrical History - A sumscore of 4 items: prior number of stillbirths, abortions, premature siblings, or neonatal death of siblings.
- X_{14} Mother's Age at Registration
- X_{15} Number of Prior Pregnancies

ξ_2 Pregnancy and Delivery Complications

- X_{21} Total Birth Complications - A count of 17 pregnancy and birth complications: placenta previa; abruptio placentae; marginal sinus rupture; uterine bleeding, first trimester; uterine bleeding, second trimester; uterine bleeding, third trimester; anesthetic shock; other anesthetic accident; caesarean or breech delivery; prolapsed cord; irregular fetal heart rate; meconium during labor; multiple birth; use of oxytocic during labor; cord around the neck, tight; cord around the neck, loose; forceps marks at delivery.
- X_{22} Duration of Labor - Sum of stages 1 and 2
- X_{23} Apgar at One Minute
- X_{24} Apgar at Five Minutes
- X_{25} Birth Weight in pounds
- X_{26} Gestational Age

ξ_3 Birth Order

- X_{31} Parity and Birth Order - Number of older siblings

ξ_4 Socioeconomic Status at Registration

- X_{41} Income at Registration into CPP
- X_{42} Mother's Education

ξ_5 Child's Physical Development at Age 7

- X_{51} Blood Pressure, Systolic
 X_{52} Blood Pressure, Diastolic
 X_{53} Weight in pounds at 7-year exam
 X_{54} Height in cms. at 7-year exam

 ξ_6 Child's Laterality at Age 7

- X_{61} Hand Preference (dummy)
 X_{62} Eye Preference (dummy)
 X_{63} Foot Preference (dummy)

 ξ_7 Family Constellation at Age 7

- X_{71} Family Size
 X_{72} Husband or Father in the Household (dummy)
 X_{73} Foster, Adoptive Parents; Guardian (dummy)
 X_{74} Marital Stability

 ξ_8 Socioeconomic Status at Age 7

- X_{81} Family Income
 X_{82} Education of Head of Household
 X_{83} Occupation of Head of Household

Latent Dependent Factors^{*} η_1 Verbal Intelligence

- Y_{11} Information scales, WISC verbal
 Y_{12} Comprehension scaled, WISC verbal
 Y_{13} Vocabulary scaled, WISC verbal
 Y_{14} Digit Span scaled, WISC verbal

Y₁₅ Spelling WRAT

Y₁₆ Reading WRAT

η_2 Spatial Intelligence

Y₂₁ Block Design scaled, WISC performance

Y₂₂ Coding scaled, WISC performance

Y₂₃ Picture Arrangement, WISC performance

Y₂₄ Arithmetic WRAT

Y₂₅ Bender-Gestalt Test, total score

Y₂₆ Goodenough-Harris Draw-A-Man Test, standard score

η_3 Verbal Achievement

Y₃₁ Vocabulary CAT

Y₃₂ Comprehension CAT

Y₃₃ Mechanics CAT

Y₃₄ Usage and Structure CAT

Y₃₅ Spelling CAT

η_4 Spatial Achievement

Y₄₁ Computation CAT

Y₄₂ Concepts and Problems CAT

- * WISC - Wechsler Intelligence Scale for Children
 WRAT - Wide Range Achievement Test
 CAT - California Achievement Test

Independent factors, were considerably different from those hypothesized initially. Altogether, the final model comprises six independent and three dependent factors, as shown in Table 2.

Independent factors changed radically, and for interesting reasons. Aside from Mother's Age (ξ_1) and Birth Weight (ξ_2), most prenatal and perinatal indicators of birth stress showed only very low correlations with intelligence, and thus could not be retained in the model. Mother's Age remained as a single indicator of prenatal and perinatal conditions because it correlated with birth-related events and with dependent factors; Birth Weight remained as an indicator of both perinatal condition and physical maturation at an early age. Socioeconomic Status at Registration (ξ_3) was a single indicator only—of family income. Laterality—Cerebral Dominance (ξ_5)—at age 7 finally comprised only hand and foot preference since eye preference was not highly correlated with intelligence. The single factor of Physical Development (ξ_4) was confirmed, however, whereas the more stable indicators of the two factors of family constellation and SES at age 7 were combined (ξ_6). In contrast, all three dependent factors were confirmed.

RESULTS

Sex Differences: Individual Indicators

Sex differences in the mean values of individual indicators are shown in Appendix A, Table A.1. In general, t-test results show few differences in independent indicators, although males have significantly heavier birth weight and higher blood pressure, height and weight at age 7. Females have a significantly higher incidence of variable foot preference. However, no sex differences exist in indicators of prenatal or perinatal stress, in family constellation, or in

TABLE 2
FINAL FACTORSLatent Independent Factors

ξ_1	<u>Mother's Age</u>
ξ_2	<u>Birth Weight</u>
ξ_3	<u>Income at Registration into CPP</u>
ξ_4	<u>Child's Physical Development at Age 7</u> Blood Pressure, Systolic Blood Pressure, Diastolic Weight Height
ξ_5	<u>Child's Laterality at Age 7</u> Hand Preference Foot Preference
ξ_6	<u>Socioeconomic Status at Age 7</u> Husband or Father in the Household Family Income at the 7-Year Exam Occupation of the Head of Household

Latent Dependent Factors

η_1	<u>Verbal Intelligence</u>
	WISC Information Comprehension Vocabulary Digit Span
	WRAT Spelling Reading Arithmetic
η_2	<u>Spatial Intelligence</u>
	WISC Block Design Coding Picture Arrangement
	Bender-Gestalt Goodenough-Harris Drawing Test
η_3	<u>Achievement</u>
	CAT Vocabulary Comprehension Mechanics Usage and Structure Spelling Computation Concepts and Problems

socioeconomic status. Thus, it can be assumed that the sexes are similar on key environmental factors and early events.

Significant sex differences exist on most dependent indicators, however. Differences at age 7 are not of a great magnitude and are inconsistent. Differences at age 15, though, are considerable and consistent. Females score significantly higher on all achievement tests, aside from Total Reading and Vocabulary, where their mean test scores are still higher. Concerning Total Battery scores, for example, females score 7 percentiles higher than males; they score 13 percentiles higher on Spelling and 10 percentiles higher on (language) Mechanics.

In general, then, test score differences are not in the direction expected for black females—i.e., distinctly higher performance on right hemispheric tasks—or in the direction found in past research for white females—i.e., distinctly higher performance on left hemispheric tasks. Whether this discrepancy from past findings is linked to the use of achievement, rather than neuropsychological, tests at later ages cannot be determined in the present study.

Sex Differences: Structural Equation Models

Parameters for the unstandardized sex comparison model and chi-square results of the model's good fit are shown in Appendix B, Table B.1. (Details of the model fitting procedure are described in Denno, 1982.) The final standardized measurement model for males for dependent and independent factors is presented in Tables B.2 and B.4, respectively; the final standardized model for females for dependent and independent factors is presented in Tables B.3 and B.5, respectively.

The final structural equation model comparing males and females is shown in Figure 2. A single coefficient on an arrow indicates that the relationship from

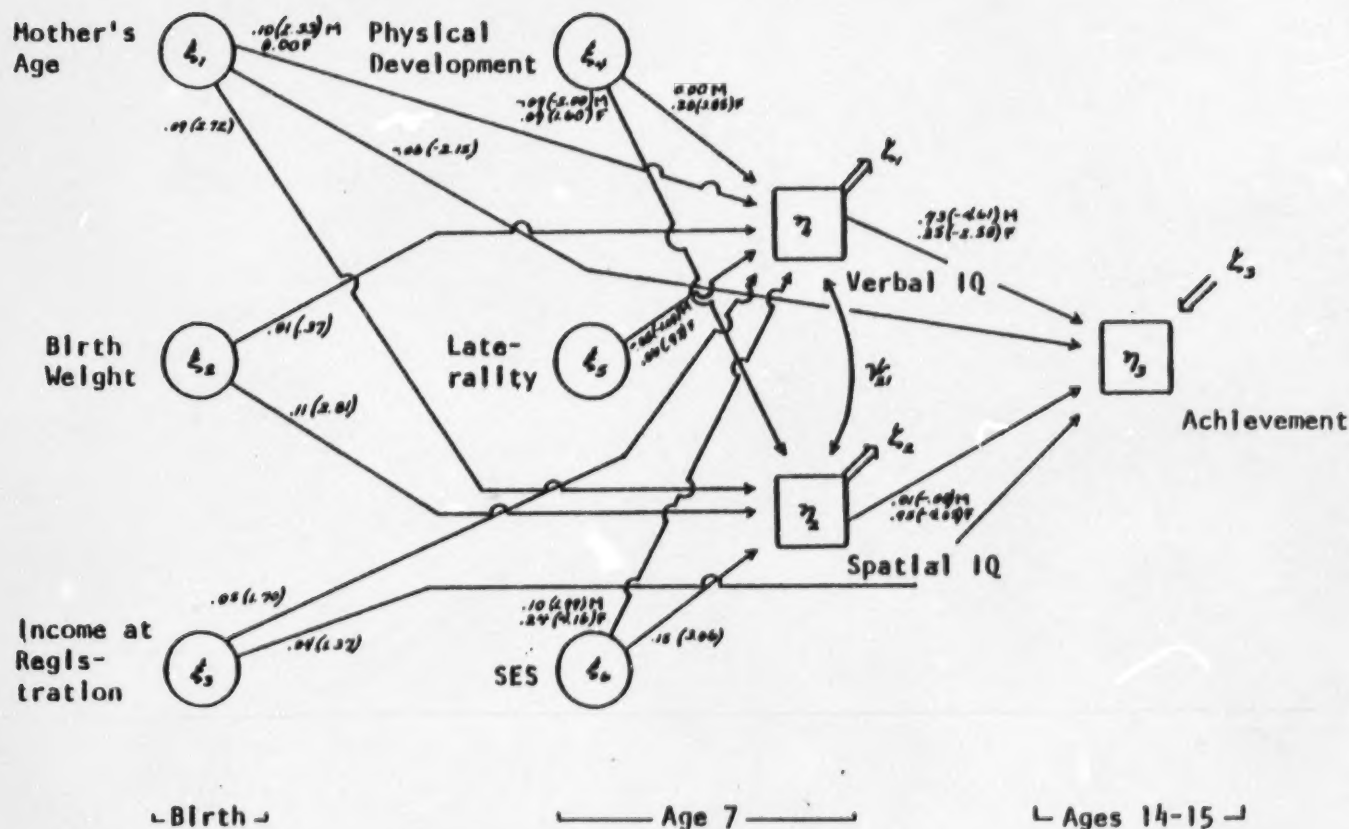


FIGURE 2. COMPARISON MODEL: MALES AND FEMALES

Note: A single coefficient on an arrow indicates that the relationship from one factor to another is identical for both sexes; two coefficients on an arrow, identified by exponents "M" and "F," indicate different relationships for males and females respectively. The t -values for coefficients are in parentheses. A t -value > 1.96 is significant at the .05 level.

one construct to another is identical for both sexes; two coefficients on an arrow, identified by exponents "M" and "F", indicate different relationships for males and females, respectively. The t values for coefficients are in parentheses. The standardized solutions for the male and female models are in Appendix C, Tables C.1 and C.2, respectively.

Figure 2 shows that clear sex differences exist in the relationship between Verbal and Spatial IQ and achievement. For males, Verbal IQ shows a highly significant direct relationship (.73) with achievement, whereas Spatial IQ shows no direct relationship (.01). For females, both Verbal and Spatial IQ show highly significant direct relationships (.25 and .45, respectively) with achievement, although the relationship with Spatial IQ is stronger. Altogether, the effect of Verbal IQ on achievement is about three times greater for males; the effect of Spatial IQ is markedly greater for females.

Relationships among independent and dependent factors show specific differences between the sexes. In general, sex differences are greatest for independent effects on Verbal IQ. Whereas Mother's Age shows a significant direct relationship (.10) with Verbal IQ among males, it shows no effect among females; in turn, Physical Development has a significant direct relationship (.20) with Verbal IQ among females but not among males. The effect of SES at Age 7 is significant for both sexes, but is about 2.5 times stronger for females.

With Spatial IQ, the same significant and positive direct relationships (.11, .15, and .09, respectively) exist for Birth Weight, SES at Age 7, and Mother's Age, for both sexes. A significant and direct negative effect (-.09) exists with Physical Development for males, but the effect (.09) is not significant for females. For achievement, only one significant independent effect appears:

for both sexes, a negative relationship ($-.06$) exists with Mother's Age.

The standardized reduced form equations represent the total impact of independent variables upon dependent variables, through the summation of direct and indirect effects. Essentially, each η is expressed exclusively in terms of ξ s. In the present structural equation model, all independent variables and the two 7-year dependent variables (Verbal and Spatial IQ) determine the ultimate dependent variable, achievement. However, the reduced form equations for Verbal and Spatial IQ are identical to their structural form equations.

Coefficients for reduced form equations are shown in Table 3. Overall, the total effect for males appears to be strongest for SES at Age 7 and Income at Registration; the effect is weakest for Physical Development. The total effect for females is strongest for SES at Age 7 and Physical Development; the effect is weakest for Cerebral Dominance and Mother's Age. Nearly half the variance in achievement is explained for both sexes by the selected variables, as well as earlier Verbal and Spatial IQ.

SUMMARY

Results of the final measurement and structural equation models were reported for males and females combined. Concerning sex differences for dependent factors, Verbal IQ showed a direct effect on achievement among males, whereas both Verbal and Spatial IQ showed direct effects on achievement among females. In comparing the sexes, the effects of Verbal IQ on achievement were clearly stronger for males, whereas the effects of Spatial IQ were markedly stronger for females.

Concerning relationships among independent and dependent factors, sex differences were clearest for Verbal IQ. Whereas Mother's Age showed a direct effect

TABLE 3
COEFFICIENTS FOR REDUCED FORM EQUATIONS FOR
MALES AND FEMALES

<u>Independent Variables</u>	<u>Males</u>	<u>Females</u>
Mother's Age	.013	.017
Birth Weight	.001	.054
Income at Registration	.070	.048
Physical Development	.001	.093
Laterality	.034	.016
SES	.077	.127
R^2	.48	.47

Dependent Variable - Achievement at ages 14-15

with Verbal IQ among males, Physical Development showed a direct effect among females. The significant effect of SES at Age 7 on Verbal IQ for both sexes was relatively stronger for females. For Spatial IQ, the same direct effects appeared for both sexes for Birth Weight, SES at Age 7, and Mother's Age. Whereas a direct negative effect existed with Physical Development for males, no significant effect appeared for females.

For both sexes, only one direct effect appeared for achievement: a negative relationship with Mother's Age. However, reduced form equations of both direct and indirect effects showed that socioeconomic influences on achievement were the strongest for both males and females. For males, the total effects of SES at Age

7 and Income at Registration were strongest among all factors; for females, the total effect of SES at Age 7 was the strongest of all factors—however, the second strongest effects, respectively, were Physical Development and Cerebral Dominance.

In general, then, the major total effects for males on achievement were related to socioeconomic or environmental factors. However, the major total effects for females were related to both socioeconomic and biological or maturational factors.

DISCUSSION

The two hypotheses suggested for this study were partially supported. Females showed evidence of greater lateralization of left and right hemispheric capacities because both Verbal and Spatial IQ at age 7 had significant effects on achievement at age 15. In contrast, only Verbal IQ had a significant effect on achievement among males. Thus, different abilities at an early age were more symmetrically related to later achievement among females; abilities were more asymmetrically related among males. These findings in general are supported in the neuropsychological literature, although no study has examined longitudinal effects on early abilities and later achievement. Correlational studies on such interrelationships are also rare.

The relatively stronger effect of Spatial IQ on achievement among females supports some evidence that females may have more pronounced right hemispheric capacities than males in black samples. In general, females have less pronounced right hemispheric capacities in white samples. Preliminary results of sex and race differences in an earlier study of the CPP sample (Denno et al., 1982) suggested that the relatively quicker maturation rate of black relative to white

females may account for differences in patterns of cerebral development. Indeed, in the present study, black males showed more pronounced left hemispheric development since only Verbal IQ was associated with achievement. This pattern is usually found among white females.

Results in the present study showing differential effects of indicators of physical maturation on verbal and spatial performance among males and females suggests that maturational influences may be important in lateralization and hemispheric specialization. Although birth weight was associated with only Spatial IQ for both sexes, later physical development was associated with Verbal IQ and achievement for females but only Spatial IQ for males. It appears that maturational effects are more continuous and symmetrical for females. This finding is striking and should be pursued in future research.

Comparisons between males and females in cognitive test scores at ages 7 and 15 showed, however, no evidence of performance in the expected direction of hemispheric development. For example, test scores at age 7 for males and females were very similar; differences that existed were slight and inconsistent with regard to verbal and spatial aptitude. At age 15, females scored considerably higher on nearly all achievement tests, although no distinct or consistent advantage was evident for tests of right hemispheric capacities, such as math. In general, then, apparent differences in the development of verbal and spatial capabilities are not necessarily linked consistently to enhanced scores on particular abilities at a later age. Whether the higher achievement scores among females are attributable to their more symmetrically developed capabilities cannot be addressed in the present study.

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APPENDIX A

TABLE A.1

VARIABLE MEANS AND STANDARD DEVIATIONS, BY SEX

VARIABLE NAME	VARIABLE LABEL	MALES		FEMALES	
		MEAN	(S.D.)	MEAN	(S.D.)
V2527	Stanford-Binet Intelligence Scale*	90.12	(12.11)	91.91	(13.53)
V2595	Graham-Ernhart Block Sort, Total Score***	31.28	(8.65)	33.49	(8.08)
V2680	Verbal IQ WISC	92.55	(11.14)	91.26	(11.49)
V2664	Information scaled, WISC verbal	9.18	(2.37)	9.10	(2.43)
V2666	Comprehension scaled, WISC verbal**	8.65	(2.45)	8.14	(2.33)
V2668	Vocabulary scaled, WISC verbal***	8.22	(2.38)	7.61	(2.30)
V2670	Digit span scaled, WISC verbal*	9.14	(2.83)	9.51	(3.05)
V2705_T	Spelling WRAT, raw score, square root transformed*	22.81	(4.67)	23.50	(4.66)
V2709_T	Reading WRAT, raw score, square root transformed*	31.36	(7.56)	32.68	(8.29)
V2682	Performance IQ WISC	94.39	(12.68)	94.33	(11.96)
V2675	Block design scaled, WISC performance*	9.09	(2.27)	8.73	(2.09)
V2677	Coding scaled, WISC performance***	9.63	(2.82)	10.54	(2.80)
PICTARR	Picture arrangement, WISC performance**	8.87	(2.74)	8.30	(2.60)
V2713_T	Arithmetic WRAT, raw score, square root transformed	20.12	(3.42)	20.43	(3.22)

VARIABLE NAME	VARIABLE LABEL	MALES		FEMALES	
		MEAN	(S.D.)	MEAN	(S.D.)
V2660	Bender-Gestalt Test, total score***	7.85	(3.36)	8.70	(3.60)
V2692	Goodenough-Harris Draw-A-Man Test, standard score***	96.63	(13.62)	93.70	(11.73)
V2684	Full Scale IQ WISC	92.79	(10.95)	92.03	(11.07)
DIQWISC	Difference IQ WISC	1.84	(13.02)	3.07	(11.92)
SC047_T	Total Reading, CAT, square root transformed	30.32	(24.53)	33.35	(25.76)
* SC050_T	Total Math, CAT, square root transformed*	22.79	(21.82)	26.95	(22.55)
SC053_T	Total Language, CAT, square root transformed***	27.00	(23.43)	36.80	(25.58)
SC055_T	Total Battery, CAT, square root transformed***	23.68	(22.54)	30.67	(24.83)
NEW2662	Bender Time (seconds)	411.03	(184.01)	400.03	(176.72)
SC045_T	Vocabulary CAT, square root transformed	33.12	(26.43)	35.99	(28.91)
SC046_T	Comprehension CAT, square root transformed**	29.64	(23.81)	33.02	(24.11)
SC051_T	Mechanics CAT, square root transformed***	28.23	(24.12)	38.97	(26.73)
SC052_T	Usage and Structure, square root transformed***	30.01	(21.78)	35.16	(23.07)
SC054_T	Spelling CAT, square root transformed***	26.82	(23.74)	39.43	(28.04)
SC048_T	Computation, CAT, square root transformed***	23.29	(21.77)	28.41	(23.32)
SC049_T	Concepts and Problems, CAT*	24.87	(22.31)	27.61	(22.01)

VARIABLE NAME	VARIABLE LABEL	MALES		FEMALES	
		MEAN	(S.D.)	MEAN	(S.D.)
PN_EXAM	Number of Prenatal Examinations	4.52	(1.33)	4.50	(1.29)
PRECON1	Number of Prenatal Conditions A sumscore of 8 items:	.80	(.84)	.71	(.91)
	SMOKING2 (1= $\geq$ 30 cigarettes per day)*	.01	(.12)	.002	(.04)
	DRUGTOT (1=sedatives were used)	.12	(.32)	.09	(.29)
	V109 (1=single)	.32	(.46)	.29	(.45)
	DIABETIC (1=present)	.01	(.10)	.01	(.10)
	NEW425 (1=hypertension)	.10	(.31)	.10	(.30)
	NEW431 (# of venereal conditions)	.12	(.45)	.12	(.45)
	NEW434 (# of neurological/ psychiatric conditions)	.05	(.23)	.06	(.27)
	NEW439 (# of infectious conditions)	.06	(.23)	.04	(.21)
POOROB1	Poor Obstetrical History A sumscore of 4 items:	.59	(1.02)	.70	(1.30)
	NEW2939 (# of fetal deaths <20 weeks)	.24	(.58)	.25	(.62)
	NEW2940 (# of fetal deaths $\geq$ 20 weeks)	.06	(.26)	.06	(.27)
	NEW2944 (# of premature siblings)	.24	(.60)	.33	(.86)
	NEW2947 (# of neonatal deaths of siblings)	.04	(.23)	.06	(.29)

VARIABLE NAME	VARIABLE LABEL	MALES		FEMALES	
		MEAN	(S.D.)	MEAN	(S.D.)
V111_T	Mother's Age at Registration, log transformed	24.18	(6.52)	24.56	(6.26)
ALLCOM	Total Birth Complications A count of 17 pregnancy and birth complications (PREGNCOM - excluding ANEMIA and DELIVCOM):	1.22	(1.08)	1.18	(1.13)
V566	Placenta Previa	.01	(.08)	.01	(.08)
V567	Abruptio Placentae	.02	(.13)	.01	(.12)
V568	Marginal Sinus Rupture	.01	(.10)	.01	(.11)
V569	Uterine Bleeding, first trimester	.10	(.30)	.10	(.31)
V570	Uterine Bleeding, second trimester	.10	(.30)	.11	(.31)
V571	Uterine Bleeding, third trimester	.17	(.38)	.19	(.39)
V572	Anesthetic Shock	.02	(.13)	.03	(.17)
V577	Other Anesthetic Accident	-	-	.002	(.04)
DELCOM, V178	Caesarean or Breech Delivery	.05	(.23)	.07	(.26)
NEW204	Prolapsed Cord	.01	(.11)	.01	(.08)
NEW220	Irregular Fetal Heart Rate	.03	(.18)	.03	(.18)
NEW221	Meconium During Labor	.24	(.43)	.22	(.41)
NEW353	Use of Oxytocic During Labor	.10	(.30)	.10	(.30)

VARIABLE NAME	VARIABLE LABEL	MALES		FEMALES	
		MEAN	(S.D.)	MEAN	(S.D.)
	NEW399 Cord around Neck, tight	.08	(.32)	.08	(.33)
	NEW400 Cord around Neck, loose	.22	(.48)	.18	(.44)
	NEW609 Forceps Marks at Delivery	.07	(.26)	.06	(.24)
	V346 Multiple Birth	.01	(.09)	.01	(.08)
LABTOT_T	Duration of Labor - Sum of Stages 1 and 2, square root transformed	7.87	(5.46)	7.57	(5.74)
NEW625_T	Apgar at One Minute, arc sine transformed	7.69	(1.86)	7.82	(1.77)
NEW631_T	Apgar at Five Minutes, arc sine transformed	8.88	(1.18)	8.90	(1.14)
BRTHLB02	Birth Weight in pounds, V597***	7.05	(1.20)	6.68	(1.11)
NEW595	Gestational Age	38.33	(3.45)	38.22	(3.72)
NEW3076_T	Parity and Birth Order - Number of Older Siblings, square root transformed	2.16	(2.15)	2.44	(2.44)
REGINC_T	Income at Registration, square root transformed, V2825 or V2921, adjusted to 1970 dollars	4130.48	(1942.31)	3991.96	(1883.1)
NW2812_T	Mother's Education, arc sine transformed	10.31	(1.94)	10.41	(1.81)
NEW1788	Blood Pressure, Systolic*	101.57	(9.72)	100.10	(9.64)

VARIABLE NAME	VARIABLE LABEL	MALES		FEMALES	
		MEAN	(S.D.)	MEAN	(S.D.)
NEW1789	Blood Pressure, Diastolic*	61.79	(7.63)	60.62	(7.80)
WT_7YR	Weight in lbs. at 7-year exam, V1783***	54.80	(10.06)	51.73	(9.11)
V1785_T	Height in cms. at 7-year exam, log transformed***	124.31	(5.64)	122.49	(5.56)
PONIN	Ponderal Index(weight/height ³)	.00003	(.00003)	.00003	(.00003)
V1920	Hand Preference, 1=left- handed	.12	(.32)	.10	(.30)
V1922	Eye Preference, 1=left-eyed	.42	(.49)	.42	(.50)
V1924_1	Foot Preference, 1=left- footed (vs. right and variable)	.10	(.30)	.10	(.30)
V1924_2	Foot Preference, 1=left or variable footed (vs. right)**	.16	(.37)	.23	(.42)
FAMSIZ_T	Family Size (sum of older and younger siblings), square root transformed	5.88	(2.38)	6.05	(2.54)
V3012	Husband or Father in the Household (1=father figure absent)	.39	(.49)	.43	(.50)
V2986	Foster, Adoptive Parents; Guardian (1=a foster child)	.03	(.18)	.02	(.13)
MARSTAB	Marital Stability (1=mother who is single or married at regis- tration but not married at the 7-year exam)	.55	(.50)	.54	(.50)
V3036_T	Number of Persons Supported In the Household	5.80	(2.14)	5.88	(2.04)
Y7RINC_T	Income at the 7-year exam, log transformed	6603.91	(3438.63)	6561.28	(3280.95)

VARIABLE NAME	VARIABLE LABEL	MALES		FEMALES	
		MEAN	(S.D.)	MEAN	(S.D.)
EDSCORE	Education of Head of Household	41.13	(20.36)	42.00	(20.30)
OCCSCORE	Occupation of Head of Household	30.31	(25.70)	32.08	(26.12)
*p<.05					
**p<.01					
***p<.001					
	N	487		500	

TABLE B.1 MAXIMUM LIKELIHOOD ESTIMATES FOR THE FINAL UNSTANDARDIZED MEASUREMENT MODEL:
ENDOGENOUS AND EXOGENOUS CONSTRUCTS - MALES AND FEMALES COMBINED

PARAMETER	λ_y	M A L E S ESTIMATE (S.E.)		F I X E D ESTIMATE (S.E.)		F E M A L E S ESTIMATE (S.E.)	
WISC Information	(1,1)			3.652	(.224)		
Comprehension	(2,1)			2.368	(.238)		
Vocabulary	(3,1)			3.784	(.230)		
Digit Span	(4,1)			4.972	(.274)		
WRAT Spelling	(5,1)			1.000	-		
Reading	(6,1)			1.358	(.048)		
Arithmetic	(10,1)	.903	(.052)			.772	(.040)
WISC Block Design	(7,2)			.060	(.051)		
Coding	(8,2)			.493	(.062)		
Picture Arrangement	(9,2)			1.000	-		
Bender-Gestalt	(11,2)			1.223	(.086)		
Goodenough-Harris Drawing	(12,2)			3.273	(.292)		
CAT Vocabulary	(13,3)			1.110	(.036)		
Comprehension	(14,3)			1.046	(.030)		
Mechanics	(15,3)			1.131	(.033)		
Usage and Structure	(16,3)			.816	(.032)		
Spelling	(17,3)			1.074	(.036)		
Computation	(18,3)	.838	(.029)			.984	(.032)
Concepts and Problems	(19,3)			1.000	-		
Age at First Arrest	(20,4)	2.310	(.079)			3.047	(.127)
Age at First Offense	(21,4)	3.513	(.219)			4.106	(.249)
Total Number of Arrests	(22,4)			1.000	-		
Damage Offender	(23,4)	.339	(.023)			.164	(.016)
Injury Offender	(24,4)	.241	(.017)			.160	(.015)

APPENDIX B

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SEX COMPARISON MODEL $\chi^2(1104) = 1127.94; p = .3015$

TABLE B.1

PARAMETER	λ_x	MALES ESTIMATE (S.E.)	FIXED ESTIMATE (S.E.)	FEMALES ESTIMATE (S.E.)
Mother's Age	(1,1)		1.000 -	
Birth Weight	(2,2)		1.000 -	
Income at Registration	(3,3)		1.000 -	
Blood Pressure, Systolic	(4,4)		.396 (.040)	
Blood Pressure, Diastolic	(5,4)		.224 (.030)	
Weight	(6,4)		1.000 -	
Height	(7,4)		.004 (.0003)	
Hand Preference	(8,5)		1.000 -	
Foot Preference	(9,5)		1.000 -	
Husband in Household	(10,6)		.036 (.004)	
Income at 7 Years	(11,6)		.041 (.005)	
Occupation	(12,6)		1.000 -	

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TABLE B.1

PARAMETER	MALES		FIXED		FEMALES	
	ESTIMATE	(S.E.)	ESTIMATE	(S.E.)	ESTIMATE	(S.E.)
θ_e (1,1)			3.976	(.195)		
(2,1)			.548	(.154)		
(3,1)			.702	(.136)		
(6,1)	0	-			.054	(.037)
(18,1)	.159	(.117)			0	-
(19,1)	0	-			.252	(.091)
(20,1)	.111	(.074)			0	-
(2,2)			4.968	(.233)		
(3,2)	1.127	(.210)			.650	(.186)
(5,2)			-.074	(.025)		
(6,2)			-.114	(.035)		
(13,2)	.300	(.140)			0	-
(15,2)	-.195	(.127)			0	-
(18,2)	.262	(.130)			0	-
(20,2)	-.091	(.082)			0	-
(21,2)	.176	(.195)			0	-
(23,2)	.048	(.021)			0	-
(3,3)	4.027	(.270)			3.021	(.220)
(5,3)			-.091	(.018)		
(10,3)	0	-			-.056	(.020)
(11,3)	-.903	(.257)			0	-
(13,3)			.453	(.089)		
(14,3)	0	-			.238	(.090)
(15,3)	-.287	(.112)			0	-
(16,3)	0	-			.379	(.116)
(18,3)	0	-			-.217	(.092)
(19,3)	.152	(.098)			0	-
(20,3)	.128	(.076)			-.092	(.039)
(21,3)	.296	(.172)			0	-
(4,4)			5.352	(.271)		
(10,4)	.092	(.032)			0	-
(5,5)	.129	(.009)			.077	(.007)
(6,5)	.102	(.009)			.070	(.008)
(8,5)			.123	(.024)		
(11,5)			.114	(.028)		
(17,5)			.094	(.016)		
(18,5)	-.062	(.020)			0	-
(19,5)	-.058	(.018)			0	-
(21,5)	.041	(.026)			0	-
(22,5)	0	-			-.001	(.002)
(23,5)	-.006	(.003)			0	-
(6,6)			.259	(.014)		
(10,6)			.019	(.004)		
(12,6)	0	-			.514	(.193)
(13,6)			.132	(.024)		
(14,6)			.096	(.020)		
(15,6)			.099	(.020)		

TABLE B.1

(16,6)	0	-			.073	(.029)
(17,6)			.264	(.028)		
(19,6)			.064	(.017)		
(20,6)	-.023	(.015)			0	-
(22,6)	0				.002	(.003)
(7,7)			3.735	(.184)		
(12,7)			2.993	(.757)		
(15,7)	.219	(.108)			0	-
(8,8)			7.223	(.335)		
(19,8)	-.285	(.134)			0	-
(9,9)			4.266	(.245)		
(14,9)	0	-			.429	(.116)
(10,10)	.068	(.006)			.049	(.004)
(11,10)			.071	(.025)		
(14,10)			-.020	(.010)		
(18,10)	.067	(.017)			.030	(.013)
(20,10)	-.028	(.015)			0	-
(22,10)	-.002	(.006)			0	-
(23,10)	-.006	(.003)			0	-
(24,10)	.004	(.003)			0	-
(11,11)			7.796	(.429)		
(12,11)	0	-			4.784	(1.418)
(15,11)	.228	(.161)			0	-
(12,12)	150.492	(10.032)			109.335	(7.431)
(13,13)			2.010	(.109)		
(14,13)	.347	(.091)			0	-
(17,13)			.255	(.074)		
(14,14)	1.461	(.122)			.954	(.088)
(15,14)	0	-			-.189	(.066)
(19,14)	.100	(.069)			0	-
(15,15)			1.218	(.080)		
(17,15)	0	-			.244	(.082)
(18,15)	.415	(.082)			.179	(.068)
(21,15)	-.142	(.110)			0	-
(22,15)			-.014	(.008)		
(16,16)			2.027	(.098)		
(18,16)	.304	(.088)			0	-
(20,16)	.127	(.053)			0	-
(17,17)			2.000	(.110)		
(19,17)	-.121	(.076)			0	-
(21,17)	-.268	(.130)			0	-
(22,17)	.024	(.019)			0	-
(18,18)	2.334	(.140)			1.879	(.117)
(19,18)			.771	(.066)		
(20,18)	0	-			.004	(.039)
(21,18)	-.229	(.115)			0	-
(22,18)			.005	(.010)		
(24,18)	.008	(.011)			0	-
(19,19)			1.282	(.073)		

TABLE B.1

	(20,19)	0	-						
	(21,19)	0	-						
	(20,20)	.658	(.108)						
	(22,20)	.094	(.039)						
	(23,20)								
	(24,20)	.062	(.015)						
	(21,21)	3.005	(.266)						
	(22,22)	.092	(.017)						
	(24,22)	.034	(.006)						
	(23,23)	.039	(.003)						
	(24,23)	0	-						
	(24,24)	.044	(.003)						
θ_6	(10,1)	-.007	(.005)						
	(12,1)								
	(4,2)	-.943	(.420)						
	(7,2)								
	(6,3)	0	-						
	(4,4)								
	(5,4)								
	(5,5)								
	(12,5)	0	-						
	(6,6)								
	(9,6)	-.216	(.089)						
	(7,7)								
	(8,8)								
	(9,9)	.054	(.005)						
	(10,10)								
	(11,11)								
	(12,12)								
B	(3,1)	3.539	(.767)						
	(3,2)	0.014	(.159)						
	(4,3)	-0.062	(.016)						
Y	(1,1)	.136	(.058)						
	(2,1)								
	(3,1)								
	(1,2)								
	(2,2)								
	(1,3)								
	(3,3)								
	(4,3)	.109	(.055)						
	(1,4)	0	-						
	(2,4)	.017	(.009)						
	(4,4)								
	(1,5)	.097	(.089)						
	(4,5)								
	(1,6)	.004	(.002)						

TABLE B.1

	(2,6)			.026	(.009)		
	(4,6)			.005	(.002)		
ψ	(1,1)	.114	(.010)			.129	(.011)
	(2,1)			.484	(.037)		
	(2,2)			2.650	(.281)		
	(3,3)			1.618	(.118)		
	(4,4)	.304	(.029)			.076	(.006)
ϕ	(1,1)			.066	(.003)		
	(2,1)			.045	(.009)		
	(3,1)			.025	(.005)		
	(4,1)	0	-			.359	(.105)
	(6,1)			.246	(.096)		
	(2,2)	1.423	(.087)			1.246	(.075)
	(4,2)			2.779	(.356)		
	(5,2)	.018	(.014)			-.020	(.011)
	(6,2)	0	-			1.431	(.558)
	(3,3)	.250	(.016)			.660	(.040)
	(6,3)			1.627	(.268)		
	(4,4)			84.132	(6.720)		
	(5,4)	.382	(.121)			0	-
	(6,4)	10.830	(4.566)			9.545	(4.770)
	(5,5)	.039	(.005)			.024	(.004)
	(6,5)	.166	(.128)			0	-
	(6,6)			89.736	(17.787)		

TABLE B.2

MAXIMUM LIKELIHOOD ESTIMATES FOR THE FINAL STANDARDIZED
(COMPARISON) MEASUREMENT MODEL: ENDOGENOUS CONSTRUCTS - MALES ONLY

<u>PARAMETERS</u>		<u>LOADINGS</u>			
WISC Information	.55	0	0	0	
Comprehension	.36	0	0	0	
Vocabulary	.58	0	0	0	
Digit Span	.62	0	0	0	
WRAT Spelling	.75	0	0	0	
Reading	.69	0	0	0	
WISC Block Design	0	.46	0	0	
Coding	0	.29	0	0	
Picture Arrangement	0	.63	0	0	
WRAT Arithmetic	.85	0	0	0	
Bender-Gestalt	0	.59	0	0	
Goodenough-Harris Drawing	0	.43	0	0	
CAT Vocabulary	0	0	.81	0	
Comprehension	0	0	.86	0	
Mechanics	0	0	.87	0	
Usage and Structure	0	0	.71	0	
Spelling	0	0	.80	0	
Computation	0	0	.68	0	
Concepts & Problems	0	0	.84	0	
Age at First Arrest	0	0	0	.81	
Age at First Offense	0	0	0	.70	
Total Number of Arrests	0	0	0	.88	
Damage Offender	0	0	0	.75	
Injury Offender	0	0	0	.58	

TABLE B.3

MAXIMUM LIKELIHOOD ESTIMATES FOR THE FINAL STANDARDIZED
(COMPARISON) MEASUREMENT MODEL: ENDOGENOUS CONSTRUCTS - FEMALES ONLY

<u>PARAMETERS</u>		<u>LOADINGS</u>			
WISC Information	.55	0	0	0	
Comprehension	.36	0	0	0	
Vocabulary	.58	0	0	0	
Digit Span	.62	0	0	0	
WRAT Spelling	.75	0	0	0	
Reading	.69	0	0	0	
WISC Block Design	0	.46	0	0	
Coding	0	.29	0	0	
Picture Arrangement	0	.63	0	0	
WRAT Arithmetic	.72	0	0	0	
Bender-Gestalt	0	.59	0	0	
Goodenough-Harris Drawing	0	.43	0	0	
CAT Vocabulary	0	0	.81	0	
Comprehension	0	0	.86	0	
Mechanics	0	0	.87	0	
Usage and Structure	0	0	.71	0	
Spelling	0	0	.80	0	
Computation	0	0	.80	0	
Concepts & Problems	0	0	.84	0	
Age at First Arrest	0	0	0	1.07	
Age at First Offense	0	0	0	.81	
Total Number of Arrests	0	0	0	.88	
Damage Offender	0	0	0	.35	
Injury Offender	0	0	0	.37	

TABLE B.4 MAXIMUM LIKELIHOOD ESTIMATES FOR THE FINAL
STANDARDIZED (COMPARISON) MEASUREMENT
MODEL: EXOGENOUS CONSTRUCTS - MALES ONLY

<u>PARAMETERS</u>	<u>LOADINGS</u>					
Mother's Age	1.08	0	0	0	0	0
Birth Weight	0	1.00	0	0	0	0
Income at Registration	0	0	1.00	0	0	0
Blood Pressure, Systolic	0	0	0	.38	0	0
Blood Pressure, Diastolic	0	0	0	.27	0	0
Weight	0	0	0	.96	0	0
Height	0	0	0	.75	0	0
Hand Preference	0	0	0	0	.58	0
Foot Preference	0	0	0	0	.58	0
Husband In Household	0	0	0	0	0	-.69
Income at 7 Years	0	0	0	0	0	.76
Occupation	0	0	0	0	0	.36

TABLE B.5 MAXIMUM LIKELIHOOD ESTIMATES FOR THE FINAL
STANDARDIZED (COMPARISON) MEASUREMENT
MODEL: EXOGENOUS CONSTRUCTS - FEMALES ONLY

<u>PARAMETERS</u>	<u>LOADINGS</u>					
Mother's Age	1.08	0	0	0	0	0
Birth Weight	0	1.00	0	0	0	0
Income at Registration	0	0	1.00	0	0	0
Blood Pressure, Systolic	0	0	0	.38	0	0
Blood Pressure, Diastolic	0	0	0	.27	0	0
Weight	0	0	0	.96	0	0
Height	0	0	0	.75	0	0
Hand Preference	0	0	0	0	.58	0
Foot Preference	0	0	0	0	.58	0
Husband In Household	0	0	0	0	0	-.69
Income at 7 Years	0	0	0	0	0	.76
Occupation	0	0	0	0	0	.36

TABLE C.1 FINAL STRUCTURAL EQUATION (COMPARISON) MODEL
(MATRIX FORM): STANDARDIZED SOLUTION - MALES ONLY*1. $\underline{B} =$

	η_1	η_2	η_3	η_4
EQ1	1.00	0.00	0.00	0.00
EQ2	0.00	1.00	0.00	0.00
EQ3	.73	.01	1.00	0.00
EQ4	0.00	0.00	-.24	1.00

2. $\underline{\Gamma} =$

	ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6
EQ1	.10	.01	.05	0.00	-.05	.10
EQ2	.09	.11	0.00	-.09	0.00	.15
EQ3	-.06	0.00	.04	0.00	0.00	0.00
EQ4	0.00	0.00	-.16	-.03	-.05	-.11

3. $\underline{\Phi^{**}} =$

	ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6
ξ_1	1.00					
ξ_2	.15	1.07				
ξ_3	.14	0.00	.55			
ξ_4	0.00	.26	0.00	1.00		
ξ_5	0.00	.09	0.00	.23	1.24	
ξ_6	.10	0.00	.25	-.12	-.10	1.00

4. $\underline{\Psi^{***}} = (\Psi_{21} \text{ free})$

	EQ ₁	EQ ₂	EQ ₃	EQ ₄
EQ1	.97			
EQ2	.96	.94		
EQ3	0.00	0.00	.52	
EQ4	0.00	0.00	0.00	.93

TABLE C.1

5. $\underline{C}^{****} =$

	η_1	η_2	η_3	η_4
η_1	.89			
η_2	.82	.99		
η_3	.66	.61	1.01	
η_4	-.18	-.17	-.26	1.62

*Correlations shown as "0.00" are fixed to zero to specify no direct relationship

**Standardized variance/covariance matrix of ξ

***Standardized variance/covariance matrix of ζ

****Standardized variance/covariance matrix of η

TABLE C.2 FINAL STRUCTURAL EQUATION (COMPARISON) MODEL
(MATRIX FORM): STANDARDIZED SOLUTION - FEMALES ONLY*

1. $\underline{B} =$

	η_1	η_2	η_3	η_4
EQ1	1.00	0.00	0.00	0.00
EQ2	0.00	1.00	0.00	0.00
EQ3	.25	.45	1.00	0.00
EQ4	0.00	0.00	-.05	1.00

2. $\underline{\Gamma} =$

	ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6
EQ1	0.00	.01	.05	.20	.06	.24
EQ2	.09	.11	0.00	.09	0.00	.15
EQ3	-.06	0.00	.04	0.00	0.00	0.00
EQ4	0.00	0.00	0.00	-.03	-.05	-.11

3. $\underline{\Phi^{**}} =$

	ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6
ξ_1	1.00					
ξ_2	.15	.93				
ξ_3	.14	0.00	1.44			
ξ_4	.15	.26	0.00	1.00		
ξ_5	0.00	-.10	0.00	0.00	.76	
ξ_6	.10	.13	.25	.11	0.00	1.00

4. $\underline{\Psi^{***}} = (\Psi_{21} \text{ free})$

	EQ ₁	EQ ₂	EQ ₃	EQ ₄
EQ1	.89			
EQ2	.91	.93		
EQ3	0.00	0.00	.52	
EQ4	0.00	0.00	0.00	.95

TABLE C.2

5. C**** =

	η_1	η_2	η_3	η_4
η_1	1.10			
η_2	.87	1.01		
η_3	.67	.66	.99	
η_4	-.07	-.06	-.07	.40

*Correlations shown as "0.00" are fixed to zero to specify no direct relationship

**Standardized variance/covariance matrix of ξ

***Standardized variance/covariance matrix of ζ

****Standardized variance/covariance matrix of η